An analysis of the ability of the "Gamma Scout" to measure DU

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I made a mistake in the first version of this paper. What it worse than making a mistake is to let it go uncorrected and live on. I am embarrassed that I left out some important beta radiations coming from the daughters of uranium-238 with very short half lives. These beta's are sufficiently energetic to be detected by the Gamma Scout and have been added in this revised paper. They come from Protactinium-234^{m} (half life 1.17 min) and Protactinium-234 (half life 6.75 hrs.). The changes are in red.

I decided to take the time to do a careful analysis of the ability of the "Gamma Scout" to measure or even detect depleted uranium (DU).

First, I looked at the radiations coming from uranium 238.

Alphas	4,2 Mev (75%) and 4.15 Mev (25%)
Betas	none but its daughter, Th-234 (half life 24 days) has a 0.191 Mev beta Pa- 234^{m} has 2.29 Mev (98%) and Pa-234 has 0.53 Mev (66%) and 1.13 Mev (13%)
Gammas	none but Th-234 has two x-rays, 0.063 Mev (3.5%) and 0.093 Mev (4.0%) Pa- 234^{m} has 0.765 Mev (0.30%) and 1.001 Mev (0.60%) Pa-234 has 0.100 Mev (.065%), 0.700 Mev (.031%), and 0.90 Mev (.091%)

Then, I looked at the limitations of the instrument as described by the manufacturer.

It is a Geiger Counter with a GM tube 38.1 mm long and 9.1 mm diameter with an end window of 1.5 to 2.0 mg/cm^2 thickness. It produces 108 pulses per minute at 1 µSv/h (100 µR/h) of Cobalt-60 radiation. That is approximately 1 count per minute (cpm) per µR/h.

It is sensitive to alpha particles which are over 4.0 Mev but does not state the efficiency.

It is sensitive to beta particles which are over 0.2 Mev but does not state the efficiency.

It is sensitive to gamma rays which are over 0.02 Mev but does not state the efficiency.

Alpha particle detection

For the "Gamma Scout", it would not be able to detect a 4.2 Mev alpha particle unless it was emitted within 1 centimeter of the end window of the GM tube. That is a pretty severe restriction if you are looking for DU in the environment. If it did count an "event" it could not tell you if it were from an alpha, beta, or gamma ray. The amount of DU necessary to emit 1 alpha per minute is 1.35 micrograms, but most of these alphas would be going in other directions away from the GM tube. It would take a particle containing 27 micrograms of DU and located within 1 cm of the GM tube window to emit an average of 1 alpha per minute reaching the window of the GM tube. When background radiation (according to their statements) is varying between 5 and 20 cpm, how can you measure DU alphas at only 1 cpm if you can't tell if the count comes from alpha, beta, or gamma radiation? To determine that you actually measure radiation which is in excess of the background measurements, you would need to have an excess which is large enough to be statistically significant. Even if you could determine that the count was from alphas and significantly above background, you would have to prove that these alphas were from DU and not from other much more abundant environmental alpha emitters such as radon.

Conclusion: I can say without any doubt that Ms. Moret did not detect or measure any alpha particles from DU with a "Gamma Scout" survey instrument. It is impossible.

Beta particle detection

For the "Gamma Scout" to detect a beta particle, it would have to be over 0.2 Mev in energy. I have calculated the effects of the beta's exceeding 0.2 Mev. The most important of these is the 2.29 Mev. Beta which has a range of 850 centimeters in air. To get enough of these beta rays to register 70 counts per minute above background on the Gamma Scout would require an air concentration of 537 grams of DU per cubic meter.

At this concentration, one cubic kilometer of air would contain 537,000 metric tons of DU. Since the entire stock of DU in the United States in 2002 was reported as 480,000 metric tons, that would require more than the entire stock of DU to be located in one cubic kilometer of air near Ms. Moret's Gamma Scout meter on that fateful day she was measuring "depleted uranium" in Hawaii. Needless to say there are many cubic kilometers of air between Ms. Moret's meter at South Kona and the Pohakuloa Training Area.

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Conclusion: I can say without any doubt that Ms. Moret's meter was not measuring betas from depleted uranium which came from the Pohakuloa Training Area.

Gamma ray dection

For the "Gamma Scout" to detect a gamma ray (or x-ray), it must be over 0.02 Mev in energy. There are two x-rays coming from the Th-234 daughter of U-238 and both are over .02 Mev. The 0.063 Mev x-ray is emitted in 3.5% of the decays and the 0.093 Mev x-ray is emitted in 4.0% of the decays. To analyze the probability of measuring any of these radiations from DU in the air or environment, I used the stated sensitivity of the instrument to Co-60 gamma rays and assumed that the low energy Th-234 x-rays would be 10 times as likely to be detected because the Co-60 gamma rays are 1.17 Mev and 1.33 Mev and are more likely to pass through the GM tube without interaction. [The number 10 is arbitrary but the difference is not likely to be more than this.] Then I took an equation from the 1970 Radiological Health Handbook (page 32) which gives the approximate exposure rate from a gamma point source. I calculated that a "point source" of one thousand grams of DU at a distance of 1 meter would give a dose rate of 1 microR/hr (2.53 microR/hr). If the detection efficiency for the weaker x-rays is 10 times the detection efficiency for Co-60 gamma rays, that should give an excess counting rate of 10 cpm above background. The addition of the other gamma rays which are closer to the energy of the cobalt-60 gamma's energy does not require a factor of 10 and adds only an additional 1.5 cpm to the 10 cpm (which is only approximate anyway). This would require only 6,000 grams of DU at a meter to produce 70 cpm above background

On April 22nd,Ms. Moret measured up to 93 cpm with her "Gamma Scout", about 70 cpm above background. Obviously this did not come from six thousand grams of DU at one meter from her instrument.

Conclusion: I can say without any doubt that any gamma radiation above background which Ms. Moret measured with her "Gamma Scout" did not come from DU.

The "Gamma Scout" is capable of measuring the beta rays from the DU decay products, but the sensitivity is not sufficient to measure the air concentrations which may be expected in the vicinity of DU weapons use. Thus the "Gamma Scout" is not capable of detecting or measuring the radiations coming from depleted uranium and should not be marketed for that purpose. If I were looking for an instrument to measure DU, I would never choose this one. In fact, I would not choose a survey meter at all. I would take samples of the soil or air and analyze them with an alpha spectrometer. I don't believe that there is any good survey instrument which will measure DU in the environment.